2016

Educational Nuclear Reactor Simulator

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MECHANICAL AND NUCLEAR

Educational Nuclear Reactor Simulator

Senior Design Team 2015-2016

Simulator Overview

The VCU Nuclear Reactor Simulator provides a solid technical and visual approach to simulating a commercial pressurized water nuclear power plant. The simulator provides several benefits for VCU including: a hands on learning instrument that can be used in nuclear engineering courses, an opportunity for students to gain experience in nuclear modeling and simulation, and a community outreach tool to expand the public's knowledge of nuclear technology.

In the six years since its inception, the only prior major modification to the simulator was the replacement of in-house written LabVIEW coding as the calculation engine with the RETRAN-3D code, a program designed for the transient thermal-hydraulic analysis of complex fluid flow systems such as nuclear reactors.

2015-2016 Enhancements

- Design focus change from that of emulating an actual plant simulator for operator training to one of enhancing student instruction in nuclear power plant design, behavior, and operation.
- Complete hardware redesign and upgrade for improved ergonomics, portability, and viewer experience.
- Upgrade of the RETRAN reactor model to a more complex and robust simulation.
- Replacement of the complex and maintenance intensive LabVIEW user-RETRAN interface with a Fortran GUI interface consisting of a single, portable process.
- Incorporation of a simpler and more intuitive user interface design allowing operation by novice users without the need for instructor supervision.

Simulator Software Model Modification

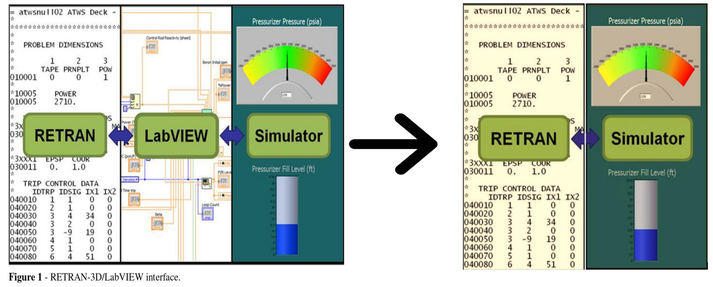
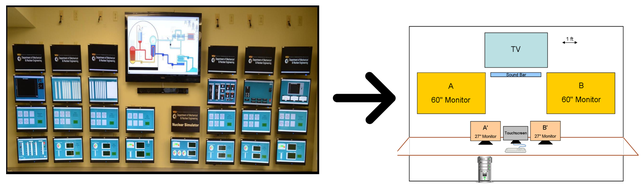


Figure 1 - RETRAN-3D/LabVIEW interface.

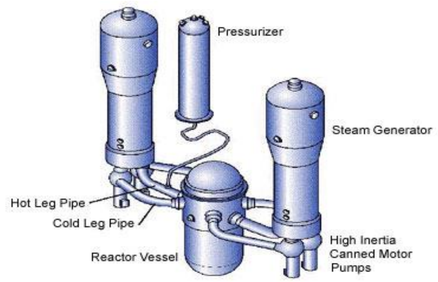
The LabVIEW GUI (Graphical User Interface) is replaced with a FORTRAN driven GUI. The simulator calculation engine (RETRAN-3D) and the user interface are integrated into a single process instead of multiple processes (LabVIEW VIs) running concurrently.

Simulator Hardware Design



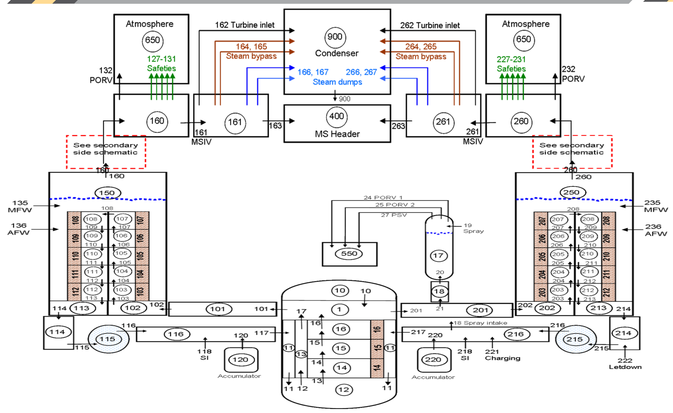
The new design provides ergonomic improvements. A simpler computer system and fewer operator screens allow the user to more easily monitor and interact with the simulator. Larger screens will enhance the viewing experience of visitors such as school groups.

PWR Model



The above diagram depicts a two-loop pressurized water reactor of a design similar to that modeled by the VCU simulator.

RETRAN-3D Model



Sample Screen Display